Innovation and development in agricultural and food systems

Guy Faure, Yuna Chiffoleau, Frédéric Goulet, Ludovic Temple and Jean-Marc Touzard, editors

EAN13 eBook [ePub] : 9782759229604

Référence eBook [ePub] : 02678EPB

Éditions Quæ
RD 10
78026 Versailles Cedex
France

Chapter 3

Agricultural research and innovation: a socio-historical analysis

FRÉDÉRIC GOULET

D

Summary. This chapter examines, in a socio-historical perspective, the place occupied by innovation in the field of agricultural research. While the notion of innovation is ubiquitous today, it is a time-honoured idea that science and technology can, and must, contribute to the transformation of agriculture. It has even been the basis of the establishment of national and international agricultural research institutions in the latter half of the 20th century. The transformation of the relationships between science, agriculture and society has, nevertheless, called this contribution into question in recent decades. In particular in the context of a crisis of confidence in the industrial agricultural model and transformations specific to the scientific field, there has been an evolution and diversification of expectations from agriculture. Agricultural research institutions have to cope with these developments, and regularly re-invent the terms of their contributions to innovation and to the transformation of agriculture.

F

How can a book on agricultural innovation which presents analyses from scientists, chiefly from agricultural research institutes, not include reflections on the relationships between these institutes and the development of innovations? Our aim in this chapter is to examine, from a socio-historical perspective (Payre and Pollet, 2013), the place occupied by the subject of innovation in the field of agricultural research. We show that, for more than half a century, profound transformations have affected the way in which agricultural research interacts with stakeholders in innovation processes, especially farmers. We note that while the objective of undertaking research to guide the transformation of productive activities and society has remained central, the modalities of doing so have, over time, taken various and diversified forms of activities and injunctions. Agricultural research here encompasses all institutions, policies and practices pertaining to the organization and conduct of scientific and technological activities related to agriculture. While this acceptation no doubt includes both public and private actors, we will mainly focus on the public sector, more specifically on French agricultural research institutes – in particular on the French National Institute for Agricultural Research (INRA) – rather than on universities, which combine higher education with research. By innovation, we mean all the technical novelties and changes in practices that affect or re-orient the practices of farmers or other agricultural production actors.

14. Implementation of applied research

Innovation is associated closely with scientific and technical activities in many sectors, and is also an outcome expected from research and development investments. Agriculture is no different in this regard and the creation of agricultural research institutes in the 20th century by nation-states was consistent with this logic. Sectoral and applied techno-scientific bodies were established during the time

industrialized countries were adopting policies for agricultural modernization, and developing countries were embracing the Green Revolution model. These bodies were tasked with meeting goals defined by public policies on the basis of the role assigned to agriculture in society. Food autonomy of countries, increased export capacities, and the fight against world hunger (Cornilleau and Joly, 2014) thus constituted central mobilizing challenges around which dedicated scientific and technical capacities were created. Research activities focused primarily on the key issues of increasing productivity and agricultural yields, most often through technologies or artifacts directly involved in production processes, such as plant genetics and seeds (Kloppenburg, 2004; Bonneuil and Thomas, 2009). This scientific and technical apparatus created and organized by the State was itself a part of the public intervention designed not only to conceive technological innovations, but also to disseminate them to producers. This is why agricultural extension and development policies and institutions emerged, to take the achievements of laboratories or experimental stations and disseminate them to farmers and rural communities. In France, for example, policies for the professionalization of farmers (Rémy, 1987), or the growth of services aimed at supporting rural households in these transformations (Brunier, 2015), constituted, within the framework of agricultural 'co-management' (Coulomb *et al.*, 1990), an essential facet of modernization policies. In any case, it is in this environment that agricultural research organizations, as we know them today, emerged, and which were given the explicit mandate of creating knowledge and technologies that could lead to a (r)evolution in the agricultural sector. Agricultural research has thus been conceived, from the very beginning, as an applied science, one that is able to generate results that can be appropriated by producers. However, despite this intention, various shifts have affected this proximity and operationality, and have led many actors to question the capacity of agricultural research institutions to come up with innovations.

15. The diversification of scientific activities and the academic shift

Activities of agricultural research institutes, their organization, and their relationship with their target audiences, have in fact evolved over time since their establishment. A major evolution concerns a dynamic internal to these institutes, arising from the significant changes affecting their agents and the nature of the knowledge they produce. First of all, scientific specialties and disciplines have progressively diversified, primarily towards agrifood technologies, and subsequently, specifically to the integration of the economic, human and social sciences, whose potential for application, while less directly related to the technologies themselves, had contrasted with the activities carried out until then. The introduction of certain disciplines such as sociology has, for a long time, been driven – and this is still the case in many emerging and developing countries – by a desire to account for the social factors facilitating or hindering the adoption by farmers of innovations conceived in laboratories or experimental stations. Subsequently, starting in the 1980s, the general evolution of the management and evaluation methods of scientific activities led in many cases to a dilution of the goal of designing innovations directly intended for the actors of agricultural modernization, or intended to respond to concrete problems that they face. Research activities have increasingly been planned according to the agendas of a globalized scientific community due to the growing specialization of research fields and a system for evaluation of researchers increasingly focused on bibliometrics (Gingras, 2014). In some industrialized countries, agricultural research has thus become a research activity 'much like any other', in the sense that it has

embraced the transversal movement sweeping the entire techno-scientific world. The recruitment of new researchers has increasingly been based more on academic excellence and association with the academia than on the knowledge and experience of the agricultural world. In this respect, the social sciences are an excellent case in point, with institutes such as INRA in France gradually favouring mastery of theoretical frameworks and the ability to publish in academic journals, rather than an in-depth knowledge of agriculture and its issues. Furthermore, in France, the disappearance of rural sociology-based thematic networks from professional associations and scientific societies, such as the French Sociology Association, speaks volumes in this regard. The rural world and agriculture have become objects to be apprehended through more generic or generalist theoretical currents and traditions, such as sociology of work, sociology of professions or, more recently, sociology of the environment, sociology of sciences and technology or economic sociology[13].

Academic excellence has thus become a leading driver of agricultural research, being placed at par with the initial focus on application – without, however, supplanting it, as is explained at the end of this section. An increased distance from actors in the field is not the only result of these developments, since very often dialogue and collaborations between different disciplines and specialities within agricultural research institutes have become a real challenge. These institutions host a very wide range of specialists and disciplines that are often disconnected from each other, interacting with difficulty despite encouragement and injunctions to promote inter-disciplinarity. Thus, an agricultural economist will probably find more topics in common for discussion with a university lecturer-researcher in economics than with a wheat geneticist working in the laboratory next door, and more than this geneticist will find in common with a soil scientist he meets every day in the institute's cafeteria! Agricultural research has, again despite its operational vocation, been following a movement since the 1980s that sometimes contributes in shifting the goal away from producing innovations and knowledge directly applicable to agriculture. In France, the recourse to external funding, formalized in 2005 by the founding of the National Research Agency (ANR), has also strengthened a logic of desectoralization, encouraging agricultural research to follow the same rules as generalist universities and institutes when seeking funding or undertaking evaluation.

While the identity and activities of agricultural research institutions have been undeniably and extensively influenced by these trends, accusing agricultural research of becoming an ivory tower would, however, be specious. Some dynamics originating from the management of institutes, or the researchers themselves, have indeed helped maintain the link to actors on the ground and the transformative ambition of agricultural research. As an example, we can mention the creation in the 1970s of INRA's Science for Action and Development department (SAD, previously known as Agrarian Systems and Development) to offer a systemic alternative to disciplinary segmentation and opportunities for action- and development-based research (Cornu, 2012). From an international perspective, we can also note the creation in the 1980s of the Agricultural Research Centre for International Development (CIRAD), institutionalizing the existence of agricultural research for

[13] Let us note, however, the continued existence of the *Société française d'économie rurale* (French Society of Rural Economics) which, despite its name, accords an important place to the pluralism of disciplines and approaches in the social sciences.

development aid in the countries of the Global South. Similarly, once again in the French national context, it is worthwhile mentioning the establishment of financing instruments in the 1990s, such as the Program For and On Regional Development (PSDR, co-funded by INRA and French Regions), aimed at orienting interdisciplinary research to respond to the needs of the local actors. Finally, in the 2000s, structures such as Mixed Technological Networks (RMT) were set up to maintain, or even strengthen, relations between research institutions and actors working for the transformation of the agricultural and agrifood sectors. Thus, as the title of this section states, the academic turn taken by agricultural research institutions is part of a diversification of activities and missions, coexisting with various initiatives aimed at maintaining or promoting a high potential for applicability by the farming and rural actors.

16. New relationships between agriculture, science and society

In addition to this interpretation of transformations of the techno-scientific world, other levels of analysis that refer to external factors make it possible to diagnose the changes in agricultural research vis-à-vis innovation. The reason agricultural research has changed is because the agricultural world itself has undergone transformations that have made it more difficult for agricultural research to produce innovations. More specifically, the diversification of agricultural production and development models (Lemery, 2003) has contributed strongly to the questioning of the choices made by agricultural research organizations regarding the goals and themes they have favoured thus far and, consequently, has made their task more complicated. Expectations from and new requirements concerning the environment, food quality, or animal welfare, and therefore the new mandates (Hugues, 1996) entrusted by society to agriculture, have upset the existing contractual relationship between the domains of agricultural production and public action in the techno-scientific field. Reflecting this evolution, agricultural research institutions have reshaped themselves to be able to address not only agriculture, but also food and environmental matters. In addition to these trends specific to the agricultural sector, there are tensions pertaining to the more general relationships between science and society, with certain technological innovations inviting strident criticism because of the risks they entail (Beck, 2001). This is especially the case of genetically modified organisms, which have generated particularly strong protests and controversies (Bonneuil *et al.,* 2008), including within the scientific community (Bonneuil, 2006), or technologies such as animal cloning, which have given rise to ethical concerns. In this context of changing relationships between agriculture and society, and between science and society, it is no longer so much the issue of how agricultural research can or must generate innovations for the sake of improved or increased production. Instead, the issue concerns the factors that make it possible to identify desirable or legitimate innovations from social, economic, moral and ethical points of view, especially in the context of a growing involvement of non-scientists in making techno-scientific choices. More than the choice of the ‘good’ technological option or the ‘good’ innovation between several possibilities, it is increasingly often the challenge of a coexistence of innovations pertaining to contrasting production and development models that is being highlighted (Hubbard and Hassanein, 2013) or, at any rate, that is currently being raised within agricultural research institutions.

17. Challenging the established division of tasks

Positioned as it is, at the intersection of dynamics concerning both external actors and protagonists of the scientific world, agricultural research found its role as a designer of technological innovations subject to debate as far back as the 1970s. Indeed, even as agricultural modernization was in full flow, the linear and Fordist model of agricultural innovation was already inviting criticism, especially because of its mainly top-down approach to development and, consequently, of its tendency to ignore the ability of farmers to produce innovations. While some studies even questioned the actual existence of this linear model (Edgerton, 2004), the ability of farmers to be more than mere recipients of innovations conceived in techno-scientific spheres became the cornerstone of a body of engaged literature (Chambers, 1983; Darré, 1999). In this reflection, farmers were also seen to be a source of knowledge and creativity, a fact stressed by authors who were calling the industrial development model into question. The emergence of several alternative agricultural models is thus most often presented as the outcome of the commitment of and experiments conducted by farmers: organic farming (Barres *et al.*, 1985), biodynamic agriculture (McMahon, 2005), and conservation agriculture (Coughenour, 2003) would thus constitute sets of technical innovations developed on the margins of official agricultural research and development systems. Indeed, this is a rather idealistic, or even populist, vision of innovation that is tending to consolidate itself (Thompson and Scoones, 1994), often allied with a sometimes radical criticism of science and technology, despite the fact that in many cases the farmers concerned do not progress alone but do so with support, especially from private operators who supply them with inputs and equipment (Goulet, 2011; Goulet and Le Velly, 2013). What finally links these research studies to field dynamics is not any scepticism in the capacity of agricultural research to generate innovations or the relevance of these innovations. It is instead the belief that innovation necessarily originates in techno-scientific circles that is called into question, since the knowledge and experience of the user is considered valuable, as is the case in other fields (von Hippel, 1986).

A significant aspect of this criticism of the linear approach to innovation is that it does not originate only from actors who are on the outside of agricultural research. Many collectives within research institutions themselves are indeed calling for different ways of approaching innovation, challenging, for instance, the traditional boundaries between science and non-science, between research and development, or between disciplines. This is the case for example in France, within INRA's Science for Action and Development department, already mentioned above, which, since the 1970s, has been promoting systemic and interdisciplinary approaches to innovation and change, and encouraging research practices that are closely tied to action and development (Cornu, 2012). Other research organizations in France, such as CIRAD, are also defending this close link between research and development, understood here in the sense of international cooperation and provision of aid to developing countries. This is also the case in Latin American countries such as Argentina, where research groups were created at the turn of the century around family farming, demanding in a normative perspective a practice of science that is able to support the innovations produced by small farmers and to assist in an evolution towards a fairer society (Goulet, 2016). A more recent facet of these other notions of innovation, challenging the established divides between scientific actors and practitioners or the primacy of agricultural research in the production of innovations, can be observed in the interest expressed recently in open and participatory sciences by institutes such as

INRA (Houllier and Merilhou-Goudard, 2016). The amateur and user experience no longer opposes that of the scientist, and is even sought specifically for inclusion in knowledge and innovation production activities. Agricultural research thus remains at the heart of the process of the design of innovations, but only within the framework of hybridization in which users and amateurs play an active role, just as they do in other scientific and technological fields (Charvolin *et al.*, 2007; Demazière *et al.*, 2009; Meyer, 2012).

18. Agricultural science and research at a time when impact reigns supreme

The creation of major national agricultural research institutes over 50 years ago was rooted in a context of the primacy of nation-states, and formed part of a modernization project in which science and technology occupied a central role. However, things have changed now. The nation-state no longer occupies a central place in the governance of our societies, or, at the very least, has lost its prominence. Modernization based on the use of chemical inputs and mechanization is no longer considered the sole solution to the challenges facing agricultural sectors both in industrialized as well as emerging or developing countries. While environmental issues have played a key role in the emergence of alternatives in the former, social issues, especially with the institutional consolidation of the family farming category, have done so in the latter (Gisclard and Allaire, 2012). And finally, the forms of governance of techno-sciences have changed considerably (Pestre, 2014), especially regarding the manner in which they are linked to societal and economic issues, and, more specifically, vis-à-vis their contribution to innovation. While techno-scientific activities, in general, have probably never been independent of political or market forces (Pestre, 2003), the recent decades have seen a shift in how their contribution to the increasingly important issues of innovation and change has been perceived and encouraged. It is relevant here to cast a glance at this recent history to understand where exactly is agricultural research situated today in its contemporary forms of existence.

The 1970s and 1980s saw the enlistment of science and technology in a globalized neoliberal economic regime, in which they were used less to promote the development of nation-states than to bolster the competitiveness of countries in the context of international economic competition (Bonneuil and Joly, 2013). The rise of internationalized companies in the race for innovation, the growing importance of intellectual property, and the decline in public funding of research and development activities were key elements of this approach, marked by a withdrawal of the State. Public scientific and technical institutions became actors, among others, of national innovation systems that the Organisation for Economic Co-operation and Development (OECD) sought to support in the 1990s (Godin, 2009). While allocations by the State of resources to the scientific sector were designed to raise the performance of countries in the international competition for rankings and scientific discoveries, they also primarily helped reinforce industrial and economic competitiveness through appropriable research and legal and commercial protection of scientific knowledge (Popp Berman, 2012). As far as the management of the scientific sector itself was concerned, the forms of administration relied on the new public management methods to accentuate a shift towards the measurement of individual performance (Bezes *et al.*, 2011), especially in the academic field mentioned above, or towards flexibility and competitiveness for obtaining project

funding (Braun, 1998). New services and departments were created within the techno-scientific institutions to promote and organize connections with field actors, especially in the business sector. In French agricultural research institutions, such as INRA (with INRA-Transfert) or CIRAD (with its Technology Transfer and Development Office), programmes and subsidiaries were created in the early 2000s to transfer research results, to support researchers in their collaboration with the private sector, or even to promote the creation of innovative companies.

More recently, this neoliberal turn is being expressed specifically through a top-down control of scientific activities so that they can contribute to a transformation of the agricultural world that is more attuned to meeting the new societal challenges. Indeed, agricultural research is now part of a strategic science regime (Rip, 2004) in which the governance of techno-sciences is based both on the pursuit of an objective of academic excellence as well as on the contribution they can make towards finding solutions to the concrete problems confronting societies. To make scientific research more operational or applied in nature, especially to justify its funding in tight budgetary contexts, the major challenges have to first be defined correctly (Foray *et al.*, 2012; Kuhlmann and Rip, 2014). The researchers are then expected to mobilize and demonstrate their ability to find solutions to these challenges for the future. For example, the European Union Horizon 2020 programme and that of the French National Research Agency identify major challenges in the fields of energy, health, food, agriculture, transport and climate that researchers are invited to address. In the agricultural field, Wright (2012) has thus highlighted how, in the centres of the CGIARs (Consultative Group on International Agricultural Research), funding is being directed towards major challenges, such as world hunger and increased yields. To choose these challenges, and more precisely the terms that identify them, 'umbrella' concepts (Rip and Voß, 2013) which can address both current social issues and science have to be used. Thus, in the more delimited field of agricultural research institutes, terms such as 'agroecology', 'climate-smart agriculture', 'sustainable agriculture', 'food security' and 'social inclusion' have become veritable and obligatory references for researchers seeking funding and legitimacy. From the outset, the allocation of funds aims to orient the activities of researchers so that they help find solutions to problems defined as 'public' by the political sphere. The term 'innovation' as such is not always present, but the idea of producing a transformative change in society is inherently central to this way of governing science (Weber and Rohracher, 2012). Studies which have specifically examined how these forms of governance of science have or have not led to transformations in research practices remain cautious in their conclusions. They observe most often the researchers' resistance to having their agendas defined by others (Hubert *et al.*, 2012) and the opportunistic strategies adopted to adjust to an increasingly fragmented funding environment (Charlier and Delvenne, 2015). Tighter framing of research and the growing alignment of funding with predefined subjects are often even denounced as being counterproductive, described by some researchers as obstacles to innovation and creativity. But to a large extent, this is the classic ambiguity characterizing the rhetoric of justification by researchers of their activities (Gieryn, 1983), between the claim of a fundamental research and the defence of its potential for application (Calvert, 2006, Di Bello, 2013), which often surfaces in the face of these demands to make science operational.

Although, in most cases, agricultural research has not formed the empirical perimeter addressed by the studies mentioned above, it nonetheless forms part of these

dynamics aimed at bringing science closer to society, and, in this case, to the agricultural sector. Joly (2015) has thus highlighted how the activities of researchers from agricultural research institutes, and even elsewhere, is part of a regime of techno-scientific promises, within whose framework the definition and justification of new lines of research depend on the potential technological or economic benefits they could generate. Thus, it is the desire to increase the impact of publicly funded research (Gozlan, 2015) that has gradually developed, and which has engendered an intense movement in French agricultural research institutions. Indeed, INRA (Joly *et al.*, 2015), as well as CIRAD, have thus undertaken reflections and methodological studies to qualify and measure the impact of research conducted in institutes. By incorporating the motto 'Science and Impact' into its logo, INRA has even made this concern for the operational results of research activities one of the pillars of its identity, or at least of its communication interface. In this sense, the trajectory of this institute, created in 1946, constitutes in itself a testimony of this old relationship, sometimes tumultuous and currently being reinvented, between agricultural research and innovation.

19. In conclusion

So while agricultural research has, since its rise within the framework of nation-states, always been planned and administrated as applied research, aimed at generating knowledge and innovations to support agricultural production, its constituent terms, practices and the actors have evolved considerably and have diversified over time. These research institutes have in fact transformed themselves, in their composition as well as in their activities, by embracing the transversal trends sweeping the scientific world. One of the results of these evolutions has been a loosening, or at least a transformation, of the close ties that had originally been created with the agricultural world and extension workers. Agricultural research, its institutions and its researchers have gradually had to contend with very varied demands, which individuals and organizations have accommodated in different ways. The expectations of the agricultural world have evolved during the same period, developing in some cases a strong criticism of these publicly funded institutions. Furthermore, the major areas around which the missions of agricultural research were planned have also evolved, gradually including, alongside agricultural production – which has itself experienced a major diversification with, for example, the rise of organic farming –, new domains such as food quality, nutrition, and the environment. The nature of the relationship between the agricultural research community and its partners has also changed considerably. The culture of transfer to the private sector, just like that of major challenges and of impact, now generally dominates institutes, their scientific policies and researchers. Of course, innovation is not always the keyword that is systematically put forward to apprehend these dynamics, whether by analysts or their protagonists. The terms 'impact', 'social utility', and 'operationalization of science' are often mobilized, and the question can then be asked as to what constitutes innovation or what is related to it. But we have chosen here to apprehend these different terms as concerning the same dynamics, referring to the capacity of scientific activities to transform society or certain productive sectors. It is indeed this latter issue to which we want to draw the reader's attention in this chapter by emphasizing the importance of reflecting not only on the role of agricultural research in the production of innovation, but also on the ways in which innovation is actually conceived within these institutions.

Bibliography

Barres D., Bonny S., Le Pape Y., Rémy J., 1985. *Une éthique de la pratique agricole. Agriculteurs biologiques du Nord-Drôme*. Inra, Économie et sociologie rurales, Paris.

Beck U., 2001. *La société du risque : sur la voie d'une autre modernité*. Éditions Aubier, Paris.

Bezes P., Demazière D., Le Bianic T., Paradeise C., Normand R., Benamouzig D., Pierru F., Evetts J., 2011. New Public Management et professions dans l'État : au-delà des oppositions, quelles recompositions ? *Sociologie du travail*, 53(3), 293-348.

Bonneuil C., 2006. Cultures épistémiques et engagement public des chercheurs dans la controverse OGM. *Natures Sciences Sociétés*, 14, 257-268.

Bonneuil C., Joly P. B., 2013. *Sciences, techniques et société*. La Découverte, Paris.

Bonneuil C., Joly P.B., Marris C., 2008. Disentrenching experiment? The construction of GM-crop field trials as a social problem in France. *Science, Technology and Human Values*, 33(2), 201-229.

Bonneuil C., Thomas F., 2009. *Gènes, pouvoirs et profits. Recherche publique et régimes de production des savoirs de Mendel aux OGM*. FPH, Éditions Quæ, Versailles.

Braun, D., 1998. The Role of Funding Agencies in the Cognitive Development of Science. *Research Policy*, 27(8), 807-821.

Brunier S., 2015. Le travail des conseillers agricoles entre prescription technique et mobilisation politique (1950-1990). *Sociologie du travail*, 57, 104-125.

Calvert J., 2006. What's Special about Basic Research? *Science, Technology & Human Values*, 31(2), 199-220.

Chambers R., 1983. *Rural Developement. Putting the last first*. Longman, New-York.

Charlier N., Delvenne P., 2015. Actors valuing science in neoliberal science regimes. Paper presented at Changing Political Economy of Research and Innovation, San Diego, CA, March 2015.

Charvolin F., Micoud A., Nyhart L.K. (eds), 2007. *Des sciences citoyennes ? La question de l'amateur dans les sciences naturalistes.* Éditions de l'Aube, La Tour d'Aigues.

Cornilleau L., Joly P.-B., 2014. La révolution verte, un instrument de gouvernance de la « faim dans le monde ». Une histoire de la recherche agronomique internationale. *In: Le gouvernement des technosciences. Gouverner le progrès et ses dégâts depuis 1945* (D. Pestre, ed.), La Découverte, Paris.

Cornu P., 2012. La passion naturaliste. Trois études d'anthropologie historique de la question agraire à l'époque contemporaine. HDR, Université Lumière, Lyon 2.

Coughenour C.M., 2003. Innovating Conservation Agriculture: The Case of No-Till Cropping. *Rural Sociology*, 68(2), 278-304.

Coulomb P, Delorme H, Hervieu B, Jollivet M, Lacombe P. (eds), 1990. *Les agriculteurs et la politique*. Presse Sciences Po, Paris.

Darré J.-P., 1999. *La production de connaissances pour l'action. Arguments contre le racisme de l'intelligence.* Éditions de la Maison des sciences de l'homme, Paris.

Demazière D., Horn F., Zune F., 2009. Les développeurs de logiciels libres : militants, bénévoles ou professionnels ? *In: Sociologie des groupes professionnels. Acquis récents et nouveaux défis* (D. Demazière and C. Gadéa, eds), La Découverte, Paris, 285-295.

Di Bello M.E., 2013. Investigadores academicos, conocimientos cientificos y utilidad social. *REDES*, 19(36), 51-78.

Edgerton D., 2004. 'The linear model' did not exist: Reflections on the history and historiography of science and research in industry in the Twentieth Century. *In: The Science-Industry Nexus: History, Policy, Implications* (K. Grandin, N. Wormbs, S. Widmalm, eds), Science History Publications, Sagamore Beach, MA, 31-57.

Foray D., Mowery D.C., Nelson R.R., 2012. Public R&D and social challenges: What lessons from mission R&D programs? *Research Policy*, 41, 1697-1702.

Gieryn T.F., 1983. Boundary-Work and the Demarcation of Science from Non-Science: Strains and Interests in Professional Ideologies of Scientists. *American Sociological Review*, 48(6), 781-795.

Gingras Y., 2014. *Les dérives de l'évaluation de la recherche. Du bon usage de la bibliométrie.* Éditions Raisons d'agir, Paris.

Gisclard M., Allaire G., 2012. L'institutionnalisation de l'agriculture familiale en Argentine : vers la reformulation d'un référentiel de développement rural. *Autrepart*, 62, 201-216.

Godin B., 2009. National Innovation System. The System Approach in Historical Perspective. *Science, Technology & Human Values*, 34(4), 476-501.

Goulet F., 2011. Firmes de l'agrofourniture et innovations en grandes cultures : pluralité des registres d'action. *Pour*, 212, 101-106.

Goulet F., 2016. Faire science à part. Politiques d'inclusion sociale et recherche agronomique en Argentine. HDR, Université Paris-Est.

Goulet F., Le Velly R., 2013. Comment vendre un bien incertain ? Activités de détachement d'attachement d'une firme d'agrofourniture. *Sociologie du travail*, 55(3), 369-386.

Gozlan C., 2015. L'autonomie de la recherche scientifique en débats : évaluer l' « impact » social de la science ? *Sociologie du travail*, 57(2), 151-274.

Houllier F., Merilhou-Goudard, J.-B (eds), 2016. *Les sciences participatives en France. États des lieux, bonnes pratiques et recommandations*, 63 p., DOI: 10.15454/1.4606201248693647E12, <https://inra-dam-front-resources-cdn.brainsonic.com/ressources/afile/320323-7bb62-resource-rapport-de-la-mission-sciences-participatives-fevrier-2016.html> (retrieved 17 July 2018).

Hubbard K., Hassanein N., 2013. Confronting coexistence in the United States: organic agriculture, genetic engineering, and the case of Roundup Ready alfalfa. *Agriculture and Human Values*, 30, 325-335.

Hubert M., Chateauraynaud F., Fourniau J.M., 2012. Les chercheurs et la programmation de la recherche : du discours stratégique à la construction de sens.

Quaderni, 77, 85-96.

Hugues E.-C., 1996. *Le regard sociologique*. Essais choisis. EHESS, Paris.

Joly P.-B., 2015. Le régime des promesses technoscientifiques. *In: Sciences et technologies émergentes : pourquoi tant de promesses ?* (M. Audétat, ed.), Hermann, Paris.

Joly P.-B., Colinet L., Gaunan A., Lemarié S., Larédo P., Matt M., 2015. Évaluer l'impact sociétal de la recherche pour apprendre à le gérer : l'approche ASIRPA et l'exemple de la recherche agronomique. *Gérer & Comprendre*, 122, 31-42.

Kloppenburg J.R., 2004. *First the seed*. The University of Wisconsin Press, Madison, WI.

Kuhlmann S., Rip A., 2014. *The challenge of addressing Grand Challenges. A think piece on how innovation can be driven towards the "Grand Challenges" as defined under the prospective European Union Framework Programme Horizon 2020*. European Research and Innovation Area Board (ERIAB), 11 p.

Lemery B., 2003. Les agriculteurs dans la fabrique d'une nouvelle agriculture. *Sociologie du travail*, 45(1), 9-25.

McMahon N., 2005. Biodynamic Farmers in Ireland. Transforming Society Through Purity, Solitude and Bearing Witness? *Sociologia Ruralis*, 45(1-2), 98-114.

Meyer M., 2012. Bricoler, domestiquer et contourner la science : l'essor de la biologie de garage. *Réseaux*, 173-174, 303-328.

Payre R., Pollet G., 2013. *Socio-histoire de l'action publique*. La Découverte, Paris.

Pestre D. (ed.), 2014. *Le gouvernement des technosciences*. La Découverte, Paris.

Pestre D., 2003. *Science, argent et politique. Un essai d'interprétation*. Inra Éditions, Paris.

Popp Berman E., 2012. *Creating the Market University: How Academic Science Became an Economic Engine*. Princeton University Press, Princeton, NJ.

Rémy J., 1987. La crise de la professionnalisation en agriculture : les enjeux de la lutte pour le contrôle du titre d'agriculteur. *Sociologie du travail*, 29(4), 415-441.

Rip A., 2004. Strategic Research, Post-modern Universities and Research Training. *Higher Education Policy*, 17, 153-166.

Rip A., Voß J.P., 2013. Umbrella Terms as Mediators in the Governance of Emerging Science and Technology. *Science, Technology & Innovation Studies*, 9(2), 39-59.

Thompson J., Scoones I., 1994. Challenging The Populist Perspective: Rural People's Knowledge, Agricultural Research, and Extension Practice. *Agriculture and Human Values*, 11, 58-76.

Von Hippel E., 1986. Lead users: a source of novel product concepts. *Management Science*, 32(7), 791-805.

Weber K.M., Rohracher H., 2012. Legitimizing research, technology and innovation policies for transformative change. Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. *Research Policy*, 41, 1037-1047.

Wright B.D., 2012. Grand missions of agricultural innovation. *Research Policy*, 41, 1716-1728.